**Problem 1**

The available procedures are: Leslie, RandomLeslieMatrix,

RandomMC

A := RandomLeslieMatrix(4, 1);
A := [

[0., 0.7700000000, 0.3900000000, 0.9200000000, 0.7100000000],

[0.6700000000, 0, 0, 0, 0], [0, 0.7800000000, 0, 0, 0],

[0, 0, 0.5100000000, 0, 0], [0, 0, 0, 0.5300000000, 0]]

eigenvalues(A);
1.02185163330949 (will keep growing), 0.0444865892905247 + 0.569720704712488 I,

0.0444865892905247 - 0.569720704712488 I, -0.644459044426746,

-0.466365767463787

eigenvalues(RandomLeslieMatrix(4, 1));
0.639032078856761 (will go extinct), -0.490075713760592,

-0.0689906002737402 + 0.0888145909045357 I,

-0.0689906002737402 - 0.0888145909045357 I, -0.0109751645486877

eigenvalues(RandomLeslieMatrix(4, 2));
1.00510083212536 (will keep growing), -0.532477569151665 + 0.113622877205923 I,

-0.532477569151665 - 0.113622877205923 I,

0.0299271530889851 + 0.181746194696538 I,

0.0299271530889851 - 0.181746194696538 I

eigenvalues(RandomLeslieMatrix(4, 1));
0.573810986846156 (will go extinct), 0.0558141130659688 + 0.447476187129607 I,

0.0558141130659688 - 0.447476187129607 I,

-0.342719606489046 + 0.233166314363753 I,

-0.342719606489046 - 0.233166314363753 I

eigenvalues(RandomLeslieMatrix(4, 5));
1.76254979457848 (will keep growing), -0.757098147855584 + 0.719748077050894 I,

-0.757098147855584 - 0.719748077050894 I,

-0.124176749433653 + 0.402332033713593 I,

-0.124176749433653 - 0.402332033713593 I

eigenvalues(RandomLeslieMatrix(4, 1));
0.773372464041882 (will go extinct), -0.454895244274601 + 0.381560117241385 I,

-0.454895244274601 - 0.381560117241385 I,

0.0682090122536604 + 0.356996517652646 I,

0.0682090122536604 - 0.356996517652646 I

eigenvalues(RandomLeslieMatrix(4, 1));
0.572217844782183 (will go extinct), -0.268948095656863 + 0.338904875724148 I,

-0.268948095656863 - 0.338904875724148 I,

-0.0171608267342289 + 0.0329801195516102 I,

-0.0171608267342289 - 0.0329801195516102 I

eigenvalues(RandomLeslieMatrix(4, 1));
0.619601489313949 (will go extinct), -0.0660289575899175 + 0.447682669421730 I,

-0.0660289575899175 - 0.447682669421730 I, -0.455389986450418,

-0.0321535876836967

eigenvalues(RandomLeslieMatrix(4, 1));
0.356838720451296 (will go extinct), -0.200094838245382 + 0.158205283031813 I,

-0.200094838245382 - 0.158205283031813 I,

0.0216754780197337 + 0.152793308974291 I,

0.0216754780197337 - 0.152793308974291 I

eigenvalues(RandomLeslieMatrix(4, 1));
0.801093846277010 (will go extinct), -0.438226811181326 + 0.329624254497065 I,

-0.438226811181326 - 0.329624254497065 I,

0.0376798880428206 + 0.278722152187036 I,

0.0376798880428206 - 0.278722152187036 I

eigenvalues(RandomLeslieMatrix(4, 1));
0.815290960553294 (will go extinct), -0.616373732744937,

-0.0851108350428287 + 0.488224882761127 I,

-0.0851108350428287 - 0.488224882761127 I, -0.0286955577226997

**Problem 2a**

```
> P := matrix([[0.5, 0.5/3, 0.5/3, 0.5/3], [0.6/3, 0.4, 0.6/3, 0.6/3], [0.7/3, 0.7/3, 0.3, 0.7/3], [0.8/3, 0.8/3, 0.8/3, 0.2]])
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$$P := \begin{bmatrix} 0.5 & 0.1666666667 & 0.1666666667 & 0.1666666667 \\ 0.2000000000 & 0.4 & 0.2000000000 & 0.2000000000 \\ 0.2333333333 & 0.2333333333 & 0.3 & 0.2333333333 \\ 0.2666666667 & 0.2666666667 & 0.2666666667 & 0.2 \end{bmatrix}$$

**Problem 2b**

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> eigenvectors(P)
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$$\left[0.2824045315, 1, \left\{\left[\begin{array}{cccc} 0.9014974483 & -0.6685872780 & -0.2979405530 & -0.2104427297 \end{array}\right]\right\}\right], \left[0.1333333333, 1, \left\{\left[\begin{array}{cccc} 0.1410711604 & 0.5078561804 & -0.5924988760 & -0.2257138579 \end{array}\right]\right\}\right], \left[1.000000001, 1, \left\{\left[\begin{array}{cccc} 0.6962373712 & 0.6962373712 & 0.6962373697 & 0.6962373704 \end{array}\right]\right\}\right], \left[-0.0157378651, 1, \left\{\left[\begin{array}{cccc} 0.0592253636 & 0.1149943810 & 0.3512357299 & -0.6494986856 \end{array}\right]\right\}\right]$$

The eigenvector corresponding to the largest eigenvalue (scaled to sum to one) is [.25,.25,.25,.25]. The page-ranks of each site are equal. In the long run we would expect surfers to be evenly distributed across the four sites.